

Claims

1. Method for hydrometallurgical treatment of cells and batteries comprising at least a lithium-based anode, a salt dissolved in an electrolyte and a cathode comprising at least a metal or a combination of metals selected from cobalt, nickel, manganese and iron, for recovering the recoverable fractions, method characterized in that it comprises dry crushing at room temperature in an inert atmosphere, treatment by at least magnetic separation and densimetric table followed by aqueous hydrolysis, for the purposes of recovering at least the lithium in the form of carbonate or lithiophosphate, an anion of said electrolyte salt and a concentrate comprising at least one metal of said cathode.
2. Method according to claim 1, characterized in that crushing is performed in an atmosphere formed by a gas selected from argon and carbon dioxide or a mixture of argon and carbon dioxide in respective proportions of 10 % to 90 % of argon and 90% to 10% of carbon dioxide.
3. Method according to claim 2, characterized in that the proportion of argon in the argon and carbon dioxide mixture is from 10 % to 35 %.
4. Method according to any one of the claims 1 to 3, characterized in that crushing is performed by means of two successive mills the first of which operates at a maximum speed of 11 rpm and the second of which operates at a speed of less than 90 rpm.
5. Method according to claim 4, characterized in that the first mill is a rotary shearing mill whereas the second mill is an impact mill.
6. Method according to any one of the claims 1 to 5, characterized in that the homogenate resulting from the crushing operation is treated by a device that combines sieving to 3 mm followed by sieving to 500 micrometers, high-induction magnetic separation and a densimetric table and screening in order to

separate from the homogenate in a single run, a magnetic fraction, a dense non-magnetic fraction, a magnetic fraction with a low density and a fine fraction at least rich in metal oxides..

5 7. Method according to claim 6, characterized in that the fine fraction, formed the sieving undersized, is treated by leaching with water to recover soluble lithium in the form of lithiophosphate.

10 8. Method according to claim 7, characterized in that precipitation of the lithiophosphate is obtained by double modification of the pH by means of soda and phosphoric acid.

15 9. Method according to one of the claims 7 and 8, characterized in that the fine fraction, from which the soluble lithium has been removed and comprising at least the cathode composed of at least a metal or a combination of metals, is dissolved in a 2N sulphuric medium at a temperature of 80°C in the presence of steel shot in a ratio between the iron and the fine fraction from which the soluble lithium has been removed of 0.15.

20 10. Method according to claim 9, characterized in that the solution resulting from acid attack of said cathode and after purification by selective precipitation of the metallic impurities is subjected to electrolysis at a temperature of 55°C under a current density comprised between 400 and 600A/m² using two electrodes made of stainless steel and antimony-lead alloy.

25 11. Method according to claim 9, characterized in that the cobalt-rich solution in the case of a cobalt-based cathode attack is treated using hypochlorite after the pH has been regulated to a value comprised between 2.3 and 2.8 to obtain a trivalent cobalt hydroxide.

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12. Method according to claims 1 to 11, characterized in that the anion of the electrolyte salt being hexafluorophosphate PF_6 , said anion is stabilized in an aqueous solution by means of LiCl .

5 13. Method according to claim 12, characterized in that the hexafluorophosphate PF_6 anion is recovered by precipitation by means of simple ammonium salts, quaternary ammonium, ammoniac nickel complex or Dihydro-1,4-diphenyl-3,5-phenylimino-1,2,4-triazol.

10 14. Method according to claims 1 to 9, characterized in that the cathode being LiFePO_4 -based, it is treated by means of 2N sulphuric acid at 80°C and then with 30% volume hydrogenated peroxide at 60°C to separate the iron from the lithium and phosphate.